



## Two new, brachypterous *Limnellia* species from the Venezuelan Andes (Diptera: Ephydriidae)

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### Abstract

Two new, brachypterous species of *Limnellia* are described from specimens collected in the Venezuelan Andes: *L. vounitis* (Trujillo: Bocon, La Cristalina (Andes; 09°14.7'N, 70°19.1'W; 2500 m)) and *L. flavifrontis* (Mérida: Mérida, Sierra Nevada National Park (Laguna Negra; 8°47.1'N; 70°48.4'W; 3300 m)). To facilitate identification of these unusual species, we have included a diagnosis of the tribe Scatellini and of the genus *Limnellia* and have also provided an annotated key to the South American genera of this tribe. The descriptions are supplemented with illustrations, photographs, and scanning electron micrographs of external structures and structures of the male terminalia.

**Key words:** Shore flies, Ephydriinae, Scatellini, *L. flavifrontis*, *L. vounitis*, New World, Neotropical, systematics, taxonomy

### Introduction

More than twenty Dipteran families are known to have species with reduced or a complete loss of wings (Hackman 1964). Among families in the suborder Brachycera (Diptera), the Ephydriidae are one of the more representative families to exhibit this condition (Hackman 1964) with 30 species that have reduced wings to some degree (pers. obsv. of WNM). Brachyptery in shore flies, however, is unevenly distributed within the classification of the family, with a preponderance of brachypterous species being found in the tribe Scatellini (subfamily Ephydriinae). Brachypterous species in Scatellini are distributed as follows: *Scatella* (11 species), *Limnellia* (2 species), *Scatophila* (2 species), and one species in each in the following genera: *Amalopteryx* (*A. maritima* Eaton), *Haloscatella* (*H. harrisoni* Mathis, Zatwarnicki and Marris) and *Tauromima* (*T. mountwilhelmi* Papp). Other brachypterous shore flies are in the subfamilies Ilytheinae (*Hyadina vockerothi* Clausen, *Nostima semialata* (Collin), *Philygria* (5 species)), Discomyzinae (*Actocetor* (3 species), *Psilopa marginella* Fallén) and Hydrelliinae (*Hydrellia acutipennis* Harrison). Brachyptery has apparently arisen independently within the Ephydriidae many times, as these three subfamilies and their respective brachypterous species are not necessarily closely related. Unlike many species with reduced wings, brachyptery in shore flies is found thus far in both males and females.

Species of brachypterous Diptera occur more often in certain environments, such as oceanic islands, mountainous areas of high altitude, arctic and sub-Antarctic areas of low altitude, coastal and marine habitats; those not in these categories are species with terricolous or hypogeous habits, are ectoparasites or they live in social insect nests. These environments and the natural history of these groups played important roles in the evolution of reduction and/or loss of wings. Hackman (1964) provided an excellent review of these flies.

The purpose of this article is to describe two new shore-fly species from the genus *Limnellia* (Tribe Scatellini) that have brachypterous wings. We also provide illustrations, photographs, and scanning electron micrographs of external structures and of structures of the male terminalia for these species.

## Material and methods

The descriptive terminology, with the exceptions noted in Mathis (1986) and Mathis & Zatwarnicki (1990a, 1990b), follows McAlpine (1981). Zatwarnicki (1996) suggested that the pre- and postsurstylus correspond with the pre- and postgonostylus and that the subepandrial sclerite is the same as the medandrium. The terminology for structures of the male terminalia is provided directly on Figs. 38–42, 45–46. We use the term basal flagellomere for the large antennomere beyond the pedicel. We prefer this term over “first flagellomere” as there may be more than one flagellomere involved, and basal does not imply a number or numbers. We likewise do not use “postpedicel” (Stuckenberg 1999) for this antennomere because at least the multisegmented arista is beyond the pedicel in addition to the large antennomere, and postpedicel is thus ambiguous and lacking in precision.

Because specimens are small, around 1.00 mm in length, study and illustration of the male terminalia required use of a compound microscope. Dissections of male terminalia were performed following Clausen & Cook (1971) and Grimaldi (1987). Abdomens were removed with microforceps and macerated in a sodium hydroxide solution. Cleared genitalia were then transferred to glycerin for observation, description, and illustration. The dissected abdomen was placed in a plastic microvial filled with glycerin and attached to the pin supporting the remainder of the insect from which it was removed. These structures for species of *Limnellia* species are minute, and for accurate determinations using them, we often had to use a compound microscope to see them clearly.

The distribution map was made using Quantum GIS 2.8. Longitude and latitude coordinates were obtained for the locality where each specimen was collected and entered into a Microsoft Excel© spreadsheet. If unavailable directly from specimen labels, longitude and latitude were estimated using gazetteers and maps to determine the geographical coordinates. Localities of specimens were plotted on a world land projection, presented within ESRI ArcView layouts and exported as encapsulated postscript (EPS) files.

The habitus illustrations are digital photographs taken with a Visionary Digital System, enhanced using Photoshop CS5© to adjust the color and make minor corrections (e.g., remove debris). Scanning Electron Microscope (SEM) images were taken with a Hitachi®™ TM3000 desktop unit (Tungsten source). Illustrations of male terminalia were made in Adobe Illustrator CS5©.

The specimens examined for this study are in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

## Taxonomy

### Tribe Scatellini Wirth and Stone

Scatellini Wirth and Stone 1956: 466. Type genus: *Scatella* Robineau-Desvoidy 1830.—Mathis and Zatwarnicki 1995: 254–288 [world catalog].—Mathis *et al.* 2014: 561–576 [review of genera and species from Brazil].

**Diagnosis.** Specimens of Scatellini may be distinguished from other Ephydriidae by the following combination of character states: *Head*: Mesofrons subquadrate, slightly wider posteriorly, appearing dull, densely microtomentose or shiny with metallic luster; lacking interfrontal setae; usually 2 laterocline, fronto-orbital setae (most genera) or 1 (*Limnellia* Malloch, most *Scatophila* Becker). Antenna relatively short; arista essentially bare, macropubescent (most genera) or bearing long dorsal rays (*Philotelma* Becker). Face projected, setulose to moderately densely pilose, marginal setae usually larger; dorsum of interfoveal hump usually similar to rest of face, dark colored in a few species, not shiny; eye bare, usually as wide as high, nearly round to obliquely oval, generally oriented obliquely to plane of epistoma; gena short to high, usually bearing a genal seta (most genera) or lacking (*Haloscatella* Mathis, *Lamproscatella* Hendel, *Philotelma*, *Thinoscatella* Mathis); oral opening moderately large, gaping, usually concealing clypeus. *Thorax*: Dorsocentral setae 2–3 (0+2, 1+2), some setae sometimes weakly developed, the posteriormost seta displaced laterally from alignment of others; intrapostalar seta lacking or weakly developed; presutural supra-alar seta variable, subequal or larger than anterior notopleural seta (*Scatella* (*Parascatella*) Cresson) or greatly reduced, weakly developed (most genera); postsutural supra-alar seta often reduced or lacking; 2 notopleural setae, placement of posterior seta variable, usually at same level as anterior seta; proepisternum lacking setae but often with a few setulae; prosternum bare of setae or setulae; anepisternum bearing 1 large seta just dorsad of midheight along posterior margin, several smaller setulae may also be present;

anepimeron, meron, and metapleuron bare of setae. Wing hyaline to conspicuously infusate with or without white spots; costal vein extended to vein M (most genera) or to vein  $R_{4+5}$  (*Scatophila*); vein  $R_{2+3}$  usually long, terminating at approximately same distance from vein  $R_{4+5}$  as tip of vein M is from vein  $R_{4+5}$ . Hindcoxal strap not setose; pulvilli normally developed; tarsal claws short, curved. *Abdomen*: Male with 5 visible abdominal tergites, tergite 5 distinctly trapezoidal or triangular; female with 6, sometimes 7, visible tergites, tergite 5 subtrapezoidal, not triangular. Male terminalia: Surstylus usually fused with ventral margin of epandrium and not evident (most genera) or evident as lobes, perhaps secondarily developed (*Lamproscatella*, *Limnelli*); aedeagus usually a sclerotized structure (apparently basiphallus) (*Amalopteryx* Eaton, *Haloscatella* [other than New Zealand species], *Lamproscatella*, *Limnelli*, *Scatella*, *Scatophila*, *Thinoscatella*) or with a sclerotized basiphallus and a membranous distiphallus invested with short, sharp scales or scale-like thorns (some *Haloscatella* [species from New Zealand], *Philotelma*); ejaculatory apodeme lacking (*Amalopteryx*, *Haloscatella*, *Lamproscatella*, *Limnelli*, *Philotelma*, *Scatophila*, *Thinoscatella*) or present as an L-shaped, flattened (dorsoventrally) structure (*Apulvillus* Malloch, *Neoscatella* Malloch, *Scatella*, *Synhoplos* Lamb, *Teichomyza* Macquart); phallapodeme rudimentary, rod-like, lacking a keel (*Amalopteryx*, *Haloscatella*, *Lamproscatella*, *Limnelli*, *Philotelma*, *Scatophila*) or greatly reduced or lacking (*Apulvillus*, *Neoscatella*, *Scatella*, *Synhoplos*, *Teichomyza*); gonites and hypandrium fused forming a single structure (“gonal arch”) (*Amalopteryx*, *Haloscatella*, *Lamproscatella*, *Thinoscatella*, *Apulvillus*, *Neoscatella*, *Scatella*, *Synhoplos*, *Teichomyza*, ground plan of *Limnelli*) or separated into medial sclerite “hypandrium” and lateral structures representing gonites (*Philotelma*, New Zealand *Haloscatella*, most *Scatophila*) or separated medioventrally into 2 lateral structures “gonites” (most *Limnelli*) (2 separate gonites are present also in some *Scatophila* (*avida* group), in which the “hypandrium” is reduced).

**Discussion.** Olafsson (1991) suggested that the tribe Scatellini, as characterized here, is monophyletic. We are less confident of the monophyly of this tribe, and the senior author is now re-examining and reanalyzing evidence to test this hypothesis.

Many of the eight included genera (*Amalopteryx*, *Haloscatella*, *Lamproscatella*, *Limnelli*, *Philotelma*, *Scatella* [subgenera: *Apulvillus*, *Neoscatella*, *Scatella*, *Synhoplos*, *Teichomyza*], *Scatophila*, *Thinoscatella*) are found throughout the world in temperate and tropical zones. Although largely undescribed, there is considerable species diversity at higher elevations associated with the Andes in South America, where we have collected specimens at localities above 5000 m (Colombia).

Worldwide there are over 245 species in Scatellini (Mathis and Zatwarnicki 1995 and electronic updates), and in the Neotropical Region there are records of four genera and nearly 70 species with a majority being classified in the genus *Scatella* and its included subgenera.

## Key to Neotropical Genera and Subgenera of Scatellini Wirth and Stone

1. Laterocline fronto-orbital seta 0–1 ..... 2
  - Laterocline fronto-orbital setae 2 ..... 3
2. Costa short, extended to vein  $R_{4+5}$  ..... *Scatophila* Becker
  - Costa long, extended to vein M ..... *Limnelli* Malloch
3. Genal seta large, conspicuous. Wing usually with distinct to obscure pale spots (*Scatella* Robineau-Desvoidy) ..... 4
  - Genal seta greatly reduced or lacking. Wing without pale spots ..... *Haloscatella* Mathis
4. Postsutural supra-alar seta subequal in length to postalar seta ..... *Scatella* (*Parascatella* Cresson)
  - Postsutural supra-alar seta reduced, 1/2 length of postalar seta ..... 5
5. Dorsocentral setae 2 (0+2), anterior seta postsutural ..... 6
  - Dorsocentral setae 2–3 (1+1, 1+2), anterior seta presutural ..... 7
6. Wing generally darkly infusate, with evident pattern of white spots; dorsum of scutellum bare; setae of midcoxa short; male midfemur lacking row of setae ..... *Scatella* (*Scatella* Robineau-Desvoidy), in part
  - Wing lightly infusate, faintly brown, but lacking pattern of white spots; dorsum of scutellum setose, more so toward lateral margins; midcoxa with row of long setae along anteroventral surface; male midfemur with row of 7–10 long, stout setae near middle of posteroventral surface, setae longer than width of femur ..... *Scatella* (*Teichomyza* Macquart)
7. Wing micropterous, subequal to length of hindbasitarsus; pedicel with spine-like, dorsal seta subequal to length of arista. .... *Scatella* (*Synhoplos* Lamb)
  - Wing stenopterous to macropterous, if reduced, much longer than length of hindbasitarsus; seta of pedicel if present much shorter, not more than 1/2 length of arista. .... 8
8. Only 1 well-developed acrostichal seta present, inserted at suture ..... *Scatella* (*Neoscatella* Malloch)
  - Acrostichal setae generally weak, short, continuing in a postsutural row to base of scutellum ..... *Scatella* (*Scatella* Robineau-Desvoidy), in part

## Genus *Limnellia* Malloch

*Limnellia* Malloch 1925: 331 (feminine). Type species: *Limnellia maculipennis* Malloch 1925, original designation.—Andersson 1971: 53–59 [review, European species].—Mathis 1978: 250–293 [revision of Nearctic species].—Mathis 1980 [review, Neotropical fauna].—Zhang and Yang 2009: 558–64 [review, Chinese fauna].—Krivosheina 2012: 1–7 [review, Russian species].—Mathis *et al.* 2014: 563–564 [review, Brazilian species].  
*Eustigoptera* Cresson 1930: 126 (feminine). Type species: *Notiphila quadrata* Fallén 1813, original designation.—Cresson 1935: 362 [synonymy].  
*Stictoscatella* Collin 1930: 133 (feminine). Type species: *Notiphila quadrata* Fallén 1813, original designation.—Cresson 1935: 362 [synonymy].  
*Stranditella* Duda 1942: 30 (as a subgenus of *Lamproscatella*; feminine). Type species: *Notiphila quadrata* Fallén 1813, original designation.—Dahl 1959: 126 [synonymy].

**Diagnosis.** *Limnellia* is distinguished from other genera of the tribe Scatellini by the following characters: Small to moderately small shore flies, body length 1.00–2.50 mm; mostly dark brown to black, microtomentose to bare, shiny, frequently with cinereous guttate and vittate maculae; wing maculate, generally dark with white spots. *Head:* Mesofrons distinct from duller parafrons, sometimes subshiny; laterocline fronto-orbital seta 1 (rarely 2); inner and outer vertical setae both well developed; paraverticlar setae either reduced or absent; ocelli arranged in isosceles or equilateral triangle or absent. Arista at most macropubescent. Face with shallow antennal grooves; interfoveal carina not projected or creased dorsally; facial setae mostly small, hair-like. Eye nearly round. Gena relatively short, bearing 1 well-developed seta. *Thorax:* Acrostichal setae uniform in size, small, arranged in 2 rows that extend to base of scutellum; dorsocentral setae 2 (0+2); supra-alar seta either reduced or lacking; disc of scutellum bare; lateral scutellar setae usually 2, sometimes 1 or lacking. Wing maculate, mostly dark brown with white, generally guttate markings. *Abdomen:* Tergites black, becoming shiny and polished posteriorly. Male terminalia: Epandrium a closed plate around cercal cavity, bearing articulated surstyli on anterior margin; gonites elongate with broad base, bearing setae on ventral portion; phallapodeme in lateral view nearly straight or deflected medially; dorsal aedeagal opening with a fold along ventral margin; aedeagus without distiphallus; ejaculatory apodeme usually present, small.

**Discussion.** With description of the two new species below, *Limnellia* now includes 24 species worldwide (Mathis and Zatwarnicki 1995 and electronic updates) that occur in most temperate regions or at higher elevations in subtropical and tropical zones. Only two species were known previously from Neotropical Region, *L. huachuca* Mathis (Colombia, Jamaica, Mexico, and Porto Rico) and *L. itatiaia* Mathis (Brazil) (Mathis 1980, Mathis *et al.* 2014). Two species in the genus exhibit brachyptery of two different types: *L. helmuti* Hollmann-Schirmacher and Zatwarnicki has a short and broad wing, and *L. abbreviata*, has a narrow wing. Both species are incapable of flight.

The two new species described herein are closely related (see “Remarks” sections below) and form a lineage within *Limnellia* that seems to have arisen and diversified due to evolutionary pressures within the Paramo or during the development of this ecosystem.

## Key to Neotropical species of *Limnellia* Malloch

1. Thorax and abdomen generally shiny black, head yellow or black; wing conspicuously brachypterous (Figs 7, 8, 28, 36). Ocelli and ocellar setae lacking . . . . . 2
- Generally dark brown to cinereous species; wing normally developed, maculate; ocelli and ocellar setae evident . . . . . 3
2. Head shiny black; head and thorax with minute setae; tarsi entirely light brown . . . . . *L. vounitis* Costa, *et al.* **n.sp.**
- Head shiny yellow; setae of head and thorax long, conspicuous; tarsi light brown with apical 2 tarsomeres dark . . . . . *L. flavifrontis* Costa, *et al.* **n.sp.**
3. Face entirely grayish; tarsi light yellow, contrasting with black tibiae . . . . . *L. huachuca* Mathis
- Face grayish to brownish, thin gray stripe along oral and lateral margins including antennal fovea, central area brown; tarsi usually dark brown, concolorous with tibiae . . . . . *L. itatiaia* Mathis

## *Limnellia vounitis* Costa, Savaris, Marinoni & Mathis **n.sp.**

(Figs. 1–4, 7, 9–12, 15–29, 38–42, 47)

**Diagnosis.** This species is distinguished from related congeners by the following combination of characters: Very



small shore flies, body length 1.00 mm (Figs. 1–4, 16, 24); general coloration shiny black. *Head*: (Figs. 9–12, 32) Frons generally black, shiny; mesofrons without any setae or setulae, except for very small pseudopostocellar setae; ocellar triangle and ocellar setae absent (Fig. 27); 1 pair of medial vertical setae present, lateral vertical seta absent (Fig. 25); very narrow parafrons and fronto-orbital plate; 2 pairs of very small laterocline fronto-orbital setae (Fig. 26). Antenna light brown, pedicel slightly darker; arista long, about 4 times length of basal flagellomere, with very small, sparse dorsal rays (Fig. 19). Face shiny black, with transverse sculpturing; medial facial area and ventral facial margin with small and sparse setae; two vertical rows of setae approximate to parafacials (Fig. 17). Gena narrow, covered with setulae; gena-to-eye ratio 0.25. Genal seta absent or indistinguishable from setulae. Sclerotized mouth parts black, membranous parts brown.

*Thorax*: Black, short, as long as head; pleural sclerites broadly fused and difficult to discern. Mesonotum bare of microtomentum, with transverse rugosity; 2 very small acrostichal setae; 2 very small dorsocentral setae; prescutellar acrostichal setae present (Fig. 25). Scutellum very small, without setae; one notopleural seta. Pleurae covered with microtomentum. Postsutural supra-alar seta present, same length as notopleural seta. One seta on posterior margin of anepisternum. Wing (Figs. 7, 28) brachypterous; wing length 0.32 mm; dark brown, with leather-like texture, veins not visible, reduced or absent. Halter very small, near wing base (Figs. 13, 18). Legs dark brown, except for light brown tarsi; femora distinctly larger than tibiae; femora and tibiae bare of microtomentum, with sparse setulae; tarsi covered with setulae. Tarsal claws curved and pulvilli normally developed (Fig. 20).

*Abdomen*: Tergites shiny black, bare of microtomentum; with very sparse, small setulae (Figs. 16, 21, 24). Tergite 1 not visible or absent; tergite 2 larger than subsequent tergites. Male terminalia (Figs. 29, 38–42): Epandrium in posterior view (Figs. 29, 38) wider than high, more or less rectangular with corners rounded, narrowly connected dorsally above cercal cavity, ventral margin shallowly emarginated, setulae uniform in size, evenly distributed except extreme lateral margins, in lateral view (Fig. 39) broadly bar-like, dorsal third tapered to anterodorsal corner, ventral margin truncate; cercal cavity elliptical, cerci in posterior view (Fig. 38) semihemispherical, in lateral view (Fig. 39) narrowly oval, with dorsal and ventral apices rounded; surstylar plate (fused surstyli) in posterior view (Fig. 38) wider than high, octagonal, ventromedially with narrow, deep cleft, in lateral view (Fig. 39) robustly bar-like, elongate, apices truncate, very slightly tapered from base to apex; aedeagus in lateral view (Fig. 42) robustly L-shaped, base wide, basal margin truncate, with a narrow projection from posterior corner, apical arm of L tapered to point, in ventral view (Fig. 41) more or less U-shaped, basal portion deeply developed, width of gap between extended arms subequal to length of base, extended arms shallowly sinuous; phallapodeme generally reduced, in lateral view (Fig. 42) L-shaped with one arm of L much wider than other arm, in ventral view (Fig. 41) shallowly arched, with a medial, short, parallel-sided truncate projection; gonite in lateral view (Fig. 42) irregularly triangular, with narrow, dorsally oriented projection, a shorter anterior, narrow, tapered projection, and a short, wide, truncate posterior projection, in ventral view (Fig. 41) longer than wide, curved basally toward phallapodeme; sternite 5 in lateral view (Fig. 42) irregularly bar-like and one corner projected perpendicular to plane, in ventral view (Fig. 40) wider than long, pentagonal, anterior and lateral margins irregularly quadrate, posterior margin with deep, wide, V-shaped emargination.

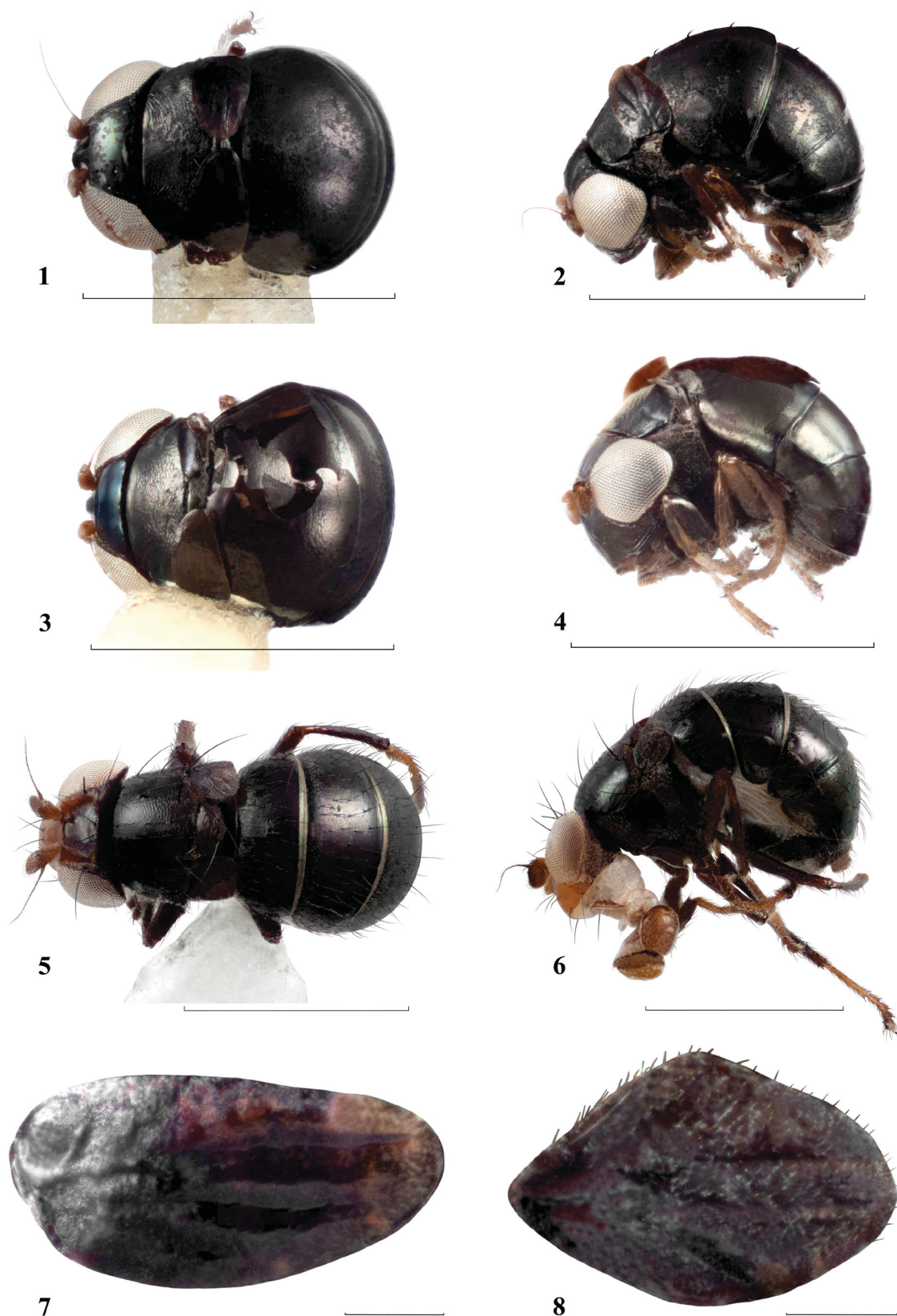
**Type material.** The holotype male of *Limnellia vounitis* is labeled “VENEZUELA. Bocon, Ande, La Cristalina, 2500 m., Subparanamo, M.G. Paoletti Feb 1987 ex: rotten wood [,] HOLOTYPE ♂/*Limnellia vounitis* Costa, Savaris, Marinoni & Mathis USNM [red]”. The holotype is glued in a paper triangle, is in average condition (some fungi on this specimen; abdomen removed and dissected, parts in an attached microvial), and is deposited in the USNM. The single female paratype (USNM) has the same date and locality label as the holotype.

**Type locality.** Venezuela. Trujillo: Bocon, La Cristalina (Andes; 09°14.7'N, 70°19.1'W; 2500 m).

**Distribution.** *Neotropical*: Venezuela (Trujillo, Fig. 48).

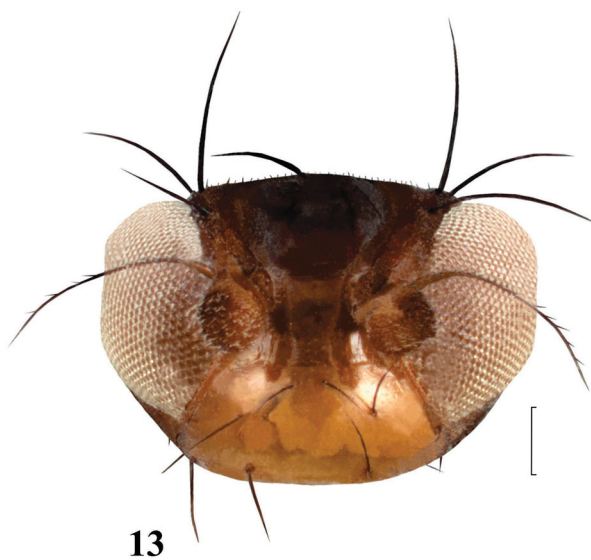
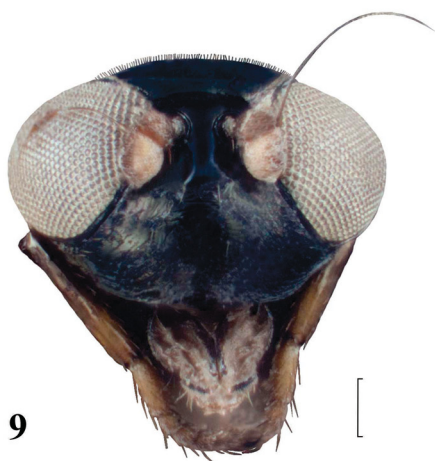
**Etymology.** The species epithet, *vounitis*, is a Latinized, masculine noun from the modern Greek word, “voynítēs” (βουνίτης), and means “dweller on the hills”, referring to the Andes Mountains of Venezuela where the type series was collected.

**Remarks.** Unlike other brachypterous species of *Limnellia*, this species has several modifications that are apparently related with its brachyptery, such as the compact thorax and reduced size of the halteres. There is also the complete loss of ocelli and ocellar setae, which may also be related with brachyptery and is a synapomorphy that is shared with the other new species being described in this paper.



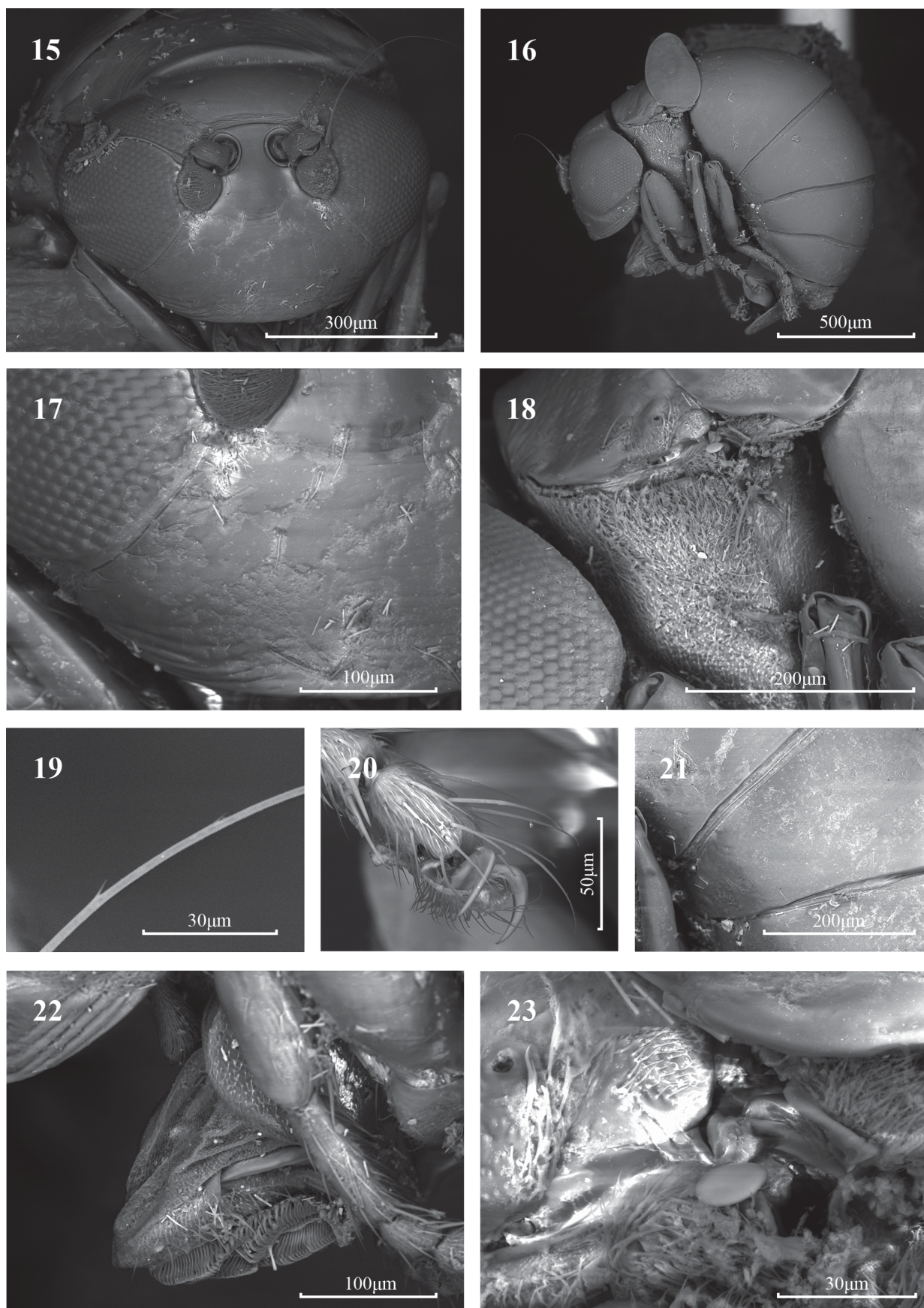
**FIGURES 1–8.** 7. Adult of *Limnellia vounitis* n.sp. (1–2, 7) Male holotype (Venezuela. Trujillo: Bocon, La Cristalina (Andes; 9°14.7'N, 70°19.1'W; 2500 m). (1) Body, dorsal view. (2) Same, lateral view. (3–4). Female paratype (3) Body, dorsal view. (4) Same, lateral view. (7) Male right wing. Figures 5–6, 8. Adult paratype of *Limnellia flavifrontis* n.sp. (5–6, 8) (Venezuela. Mérida: Mérida, Sierra Nevada National Park (Laguna Negra; 8°47.1'N; 70°48.4'W; 3300 m)). (5) Male body, dorsal view. (6) Same, lateral view. (8) Male right wing. Scale bar Figs. 1–6 = 1.0 mm; Figs. 7–8 = 0.1 mm.





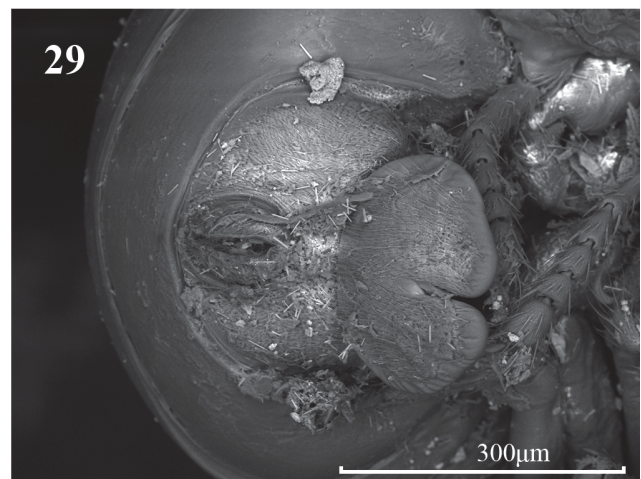
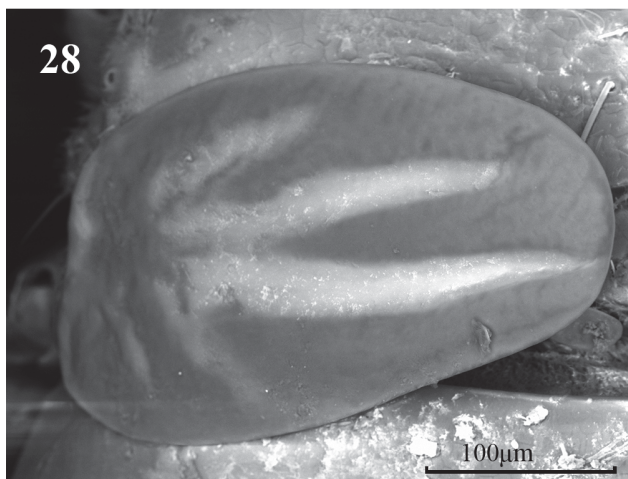
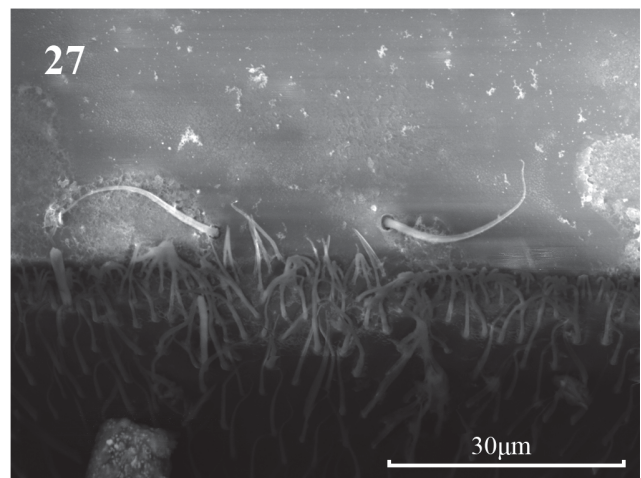
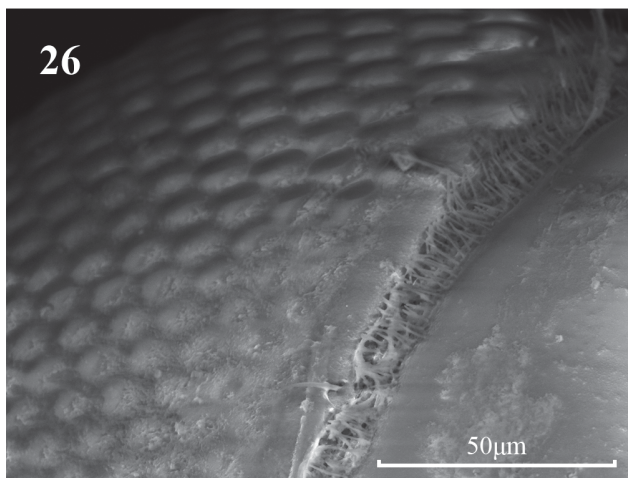
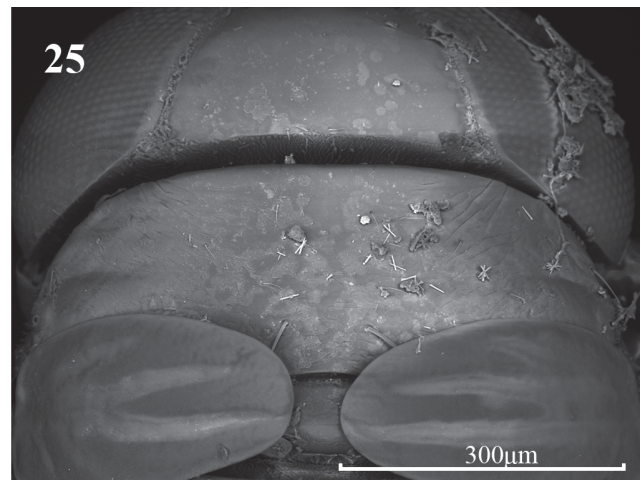
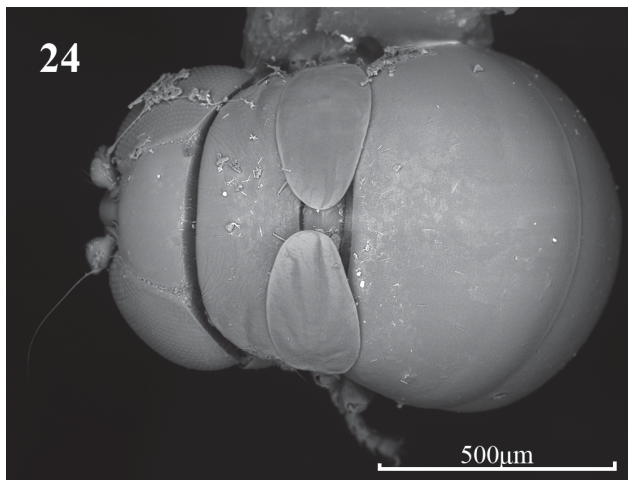
**FIGURES 9–14.** *Limnellia vounitis* n.sp. (9) Male holotype, head, anterior view. (10) Same, oblique view. (11) Female paratype head, anterior view. (12) Same, oblique view. *Limnellia flavifrontis* n.sp. (13) Male paratype, head, anterior view. (14) Same, oblique view. Scale bar = 0.1 mm.





**FIGURES 15–23.** *Limnellia vounitis* n.sp., male holotype. (15) Head, anterior view. (16) Body, lateral view. (17) Detail of face, right side, anterior view. (18) Thorax, lateral view. (19) Detail of arista. (20) Midapical tarsomere, (21) Detail of tergite 3, lateral view. (22) Mouth parts, lateral view. (23) Halter, lateral view. Scale bar on figures.





**FIGURES 24–29.** *Limnellia vounitis* n.sp., male holotype. (24) Body, dorsal view. (25) Thorax, dorsal view. (26) Detail of frons, left side, dorsal view. (27) Pseudopostocellar setae, dorsal view. (28) Left wing, dorsal view. (29) Male Terminalia, ventral view. Scale bar on figures.

Some external features of this species, such as the shape of the head, especially the widely arched, vertically elongated, and protrudent face, led us to initially associate this species with the tribe Dagini, perhaps related to the *wheeleri* species group within the genus *Physemops* Cresson. Structures of the male terminalia, however, reveal this species to be in the genus *Limnellia*, which belongs in the tribe Scatellini. Even within *Limnellia*, this is an anomalous species, given its very compact body, reduced halteres, a general reduction of setae and setulae, the conspicuous brachyptery, and the complete loss of ocelli and ocellar setae. The indication of the structure showed

in Figs. 40–42 as sternite 5 is also tentative. This sternite is in close proximity to internal structures of the male terminalia and is apparently located within the abdomen. In our specimen, we cannot determine for sure the presence of a sternite 5 in addition of this structure. Thus we hesitate to suggest that this is another structure since in *Limnellia* species the hypandrium and gonites are usually fused as a single, united structure.

According to the collector, the type series was found on rotting wood. This niche, combined with the site being at a high elevation, is typical for some flies with reduced wings and it has apparently exerted evolutionary pressure for such. Other aspects of the life history, such as the immature stages, are unknown, although the collection site suggests that this species may be saprophytic.

***Limnellia flavifrontis* Costa, Savaris, Marinoni & Mathis n.sp.**

(Figs. 5–6, 8, 13–14, 30–37, 43–48)

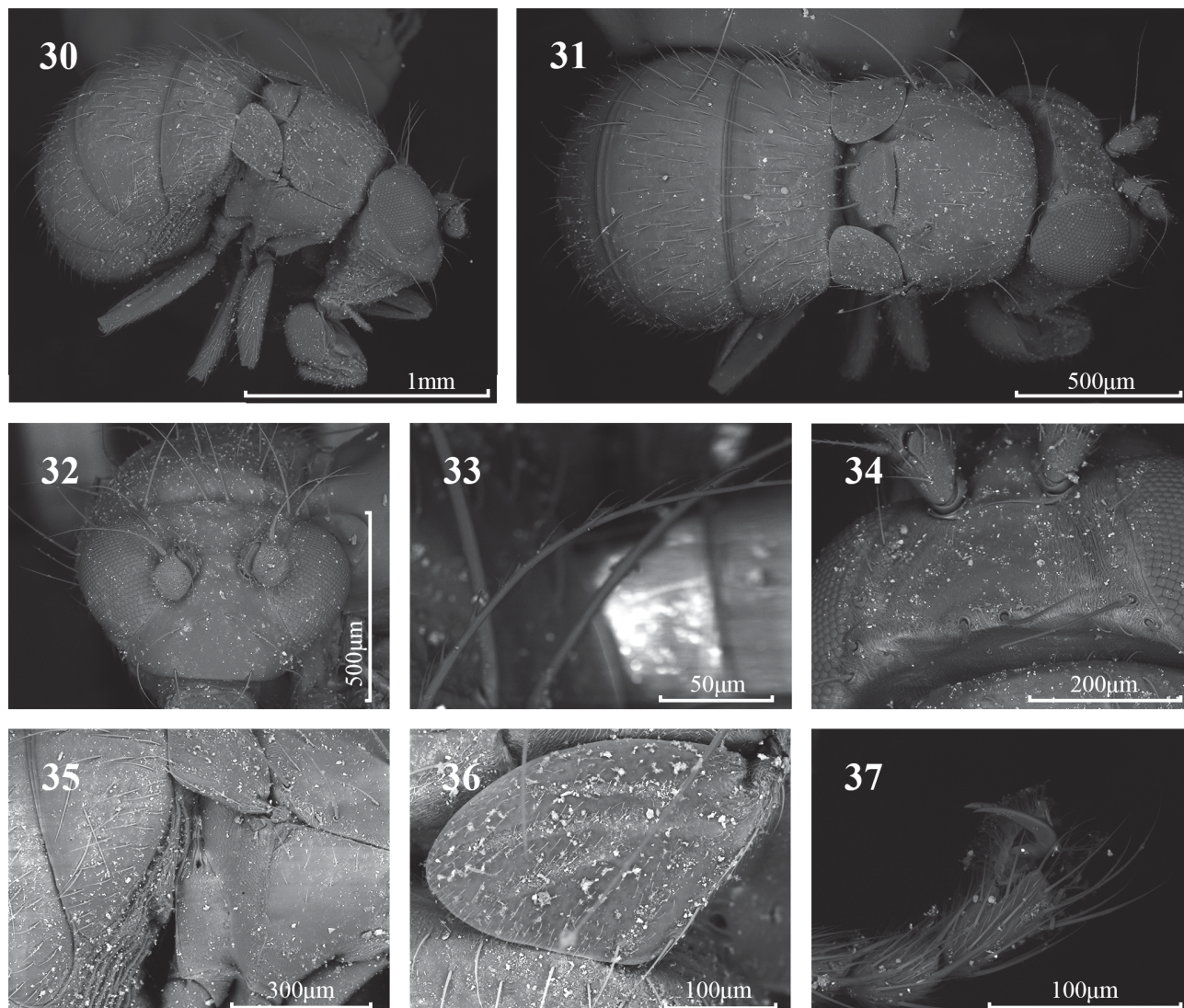
**Diagnosis.** This species is distinguished from related congeners by the following combination of characters: Very small shore flies, body length 1.80 mm (Figs. 5–6, 30–31); general coloration shiny brownish black. *Head:* Head generally yellowish, shiny; mesofrons brownish yellow, without any setae or setulae, except for well-developed pseudopostocellar setae, as long as vertical and fronto-orbital setae (Figs. 13–14, 32, 34); ocellar triangle and ocellar setae absent; medial and lateral vertical setae present, conspicuous; parafrons and fronto-orbital plate normally developed, yellow; 2 pairs of laterocline fronto-orbital setae, anterior very small, posterior well developed; Antenna yellow; arista long, about 4 times length of basal flagellomere, with very small, sparse dorsal rays (Fig. 33). Face shiny yellow, smooth; medial facial area and ventral facial margin with 8 conspicuous setae; 2 vertical rows of setae approximate to parafacials; Gena narrow and brownish yellow, sparsely setulose; gena-to-eye ratio 0.20. Genal seta present, short. Mouth parts yellow.

*Thorax:* Blackish brown, short, slightly longer than head; pleural sclerites broadly fused and difficult to discern (Fig. 35). Mesonotum bare of microtomentum; rows of acrostichal setae small but evident; prescutellar acrostichal setae present; 2 long dorsocentral setae (Figs. 30–31). Scutellum very small, with long apical setae; 2 long notopleural seta. Pleurae sparsely setulose. Postsutural supra-alar seta present, three times longer than notopleural seta; anepisternum without setae; 1 small katepisternal setae. Wing brachypterous (Figs. 8, 36); wing length 0.27 mm; dark brown, with leather-like texture, veins not visible, reduced or absent; covered with setulae and five strong setae at anterior margin. Halter absent (Fig. 35). Legs dark brown, tarsi light brown with apical 2 tarsomeres dark; femora distinctly larger than tibiae; femora and tibiae covered with setulae. Tarsal claws curved and pulvilli normally developed.

*Abdomen:* Tergites shiny black, bare of microtomentum, with small setulae (Figs. 30, 31). Tergite 1 not visible or absent; tergite 5 larger than previous tergites. Male terminalia (Figs. 43–47): Epandrium in posterior view (Fig. 43) higher than wide, more or less rectangular with irregularly arched lateral margins and rounded dorsal corners, widely connected dorsally above cercal cavity, ventral margin widely truncate, epandrial setulae uniform in size, confined to dorsal half, in lateral view (Fig. 44) with anterior margin developed at midlength into a narrow, pointed projection, between projection and ventral margin forming a 90 degree curve, cercal opening shallowly concave, tapered toward ventral apex, ventral margin pointed; cercal cavity in posterior view elliptical, rounded dorsally, ventral shallowly pointed ventrally, cerci in posterior view (Fig. 43) semihemispherical, in lateral view (Fig. 44) with anterior margin shallowly curved, posterior margin broadly and slightly tapered, bluntly rounded; surstylar plate in posterior view (Fig. 43) narrowly fused dorsally, otherwise bifurcate with narrow cleft between surstyli, in lateral view (Fig. 44) bar-like, elongate, shallowly curved ventral apex truncate, basal apex tapered, pointed, in ventral view (Fig. 45) U-shaped, gap between arms elongate, narrowly V-shaped, each arm very robustly developed, parallel sided, slightly flared laterally apically, apices truncate; aedeagus in lateral view (Fig. 47) as a C-shaped structure surrounding a bowl-like structure: C-shaped structure with a banana-like process with the apex produced into a short, recurved knob, then an elongate, narrow structure with uneven curvature, portion toward aedeagal base with curvature narrow, hook-like, extension toward fused gonite/hypandrium narrow, parallel sided, curvature shallow, little or no evidence of a keel structure with an apical, short, robust, recurved handle; bowl-like structure in lateral view (Fig. 47) with an apical, short, robust, recurved handle. C-shaped structure in ventral view (Fig. 46) narrow, linear, apex toward aedeagal base irregularly H-like, bifurcate with basal arms short, and apical arms elongate and flared apicolaterally, medial process parallel sided, pointed apically, apex toward fused gonite/



hypandrium truncate; bowl-like structure in ventral view (Fig. 46) rectangular with base truncate, basal lateral margin parallel sided, apical 1/3 tapered to rounded apex; gonite/hypandrium in lateral view (Fig. 47) irregularly L-shaped with anterior arm bent back apically, narrow, as a digitiform process, angle of L almost at a right angle, in ventral view (Fig. 46) fused gonite/hypandrium robust H, with lateral margins shallowly sinuous, anterior half pointed and oriented medially, with a medial hook-like projection that is curved anteriorly, posterior margin of each arm robust, truncate.



**FIGURES 30–37.** *Limnellia flavifrontis* n.sp., male paratype. (30) Body, lateral view. (31) Body, dorsal view. (32) Head, anterior view. (33) Detail of arista. (34) Frons, dorsal view. (35) Thorax, lateral view. (36) Right wing, dorsolateral view. (37) Midapical tarsomere. Scale bar on figures.

**Type material.** The holotype male of *Limnellia flavifrontis* is labeled “VEN: Mérida. Sierra Nevada Natl. Pk., Laguna Negra, 3300 m, 23 May 1998, elfin forest, leaf litter, R. Anderson.[.] HOLOTYPE ♂/*Limnellia flavifrontis* Costa, Savaris, Marinoni & Mathis USNM [red]”. The holotype is glued in a paper triangle, is in very good condition, and is deposited in USNM. One male and four females paratypes have the same date and locality label as the holotype.

**Type locality.** Venezuela. Mérida: Mérida, Sierra Nevada National Park (Laguna Negra; 8°47.1'N; 70°48.4'W; 3300 m).

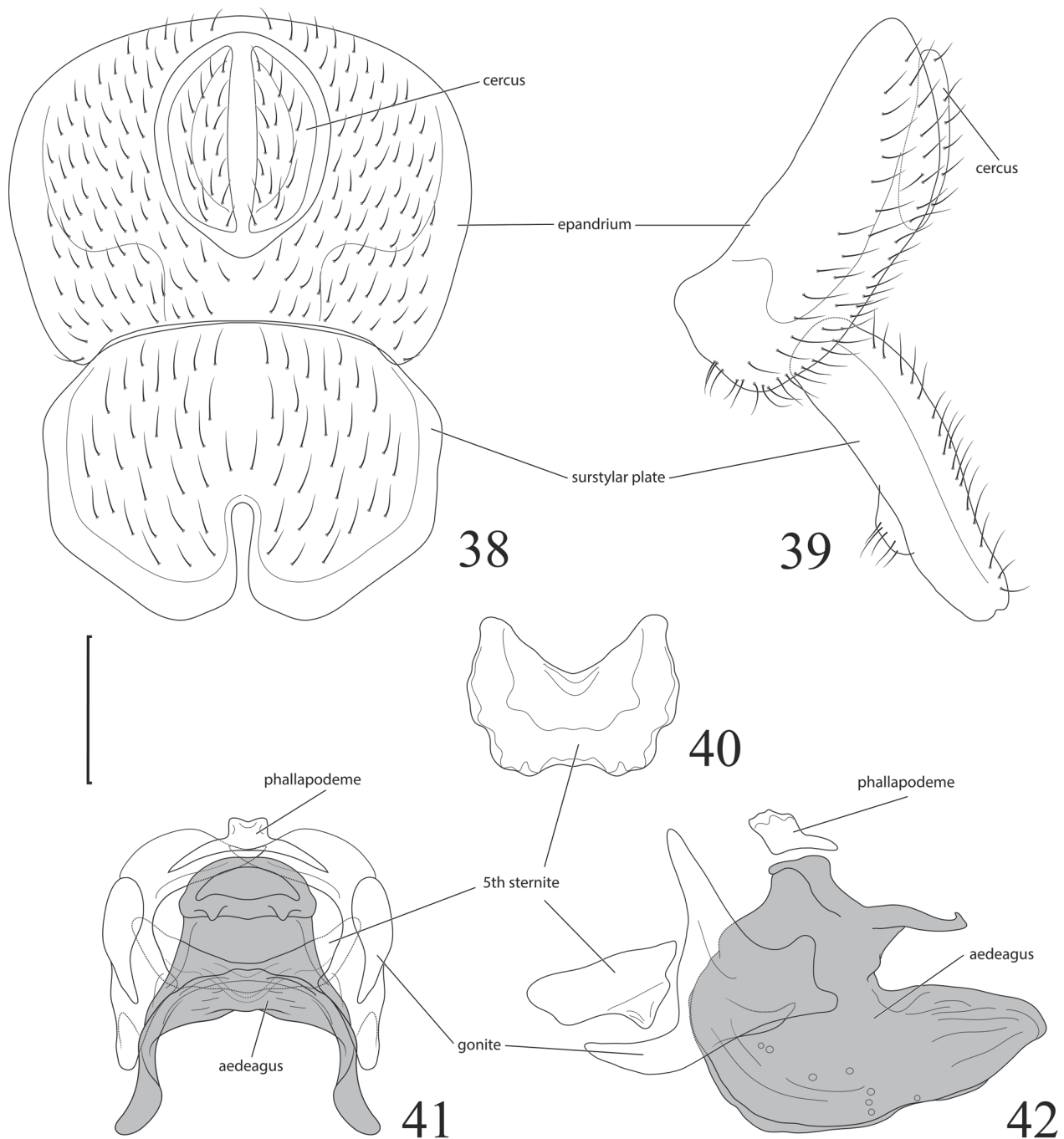
**Distribution.** *Neotropical*: Venezuela (Mérida, Fig. 48).

**Etymology.** The species epithet, *flavifrontis*, is of Latin derivation and means yellow forehead, referring to the yellowish head of this species.

**Remarks.** This species is closely related with *L. vounitis*, exhibiting many of the same modified features, such

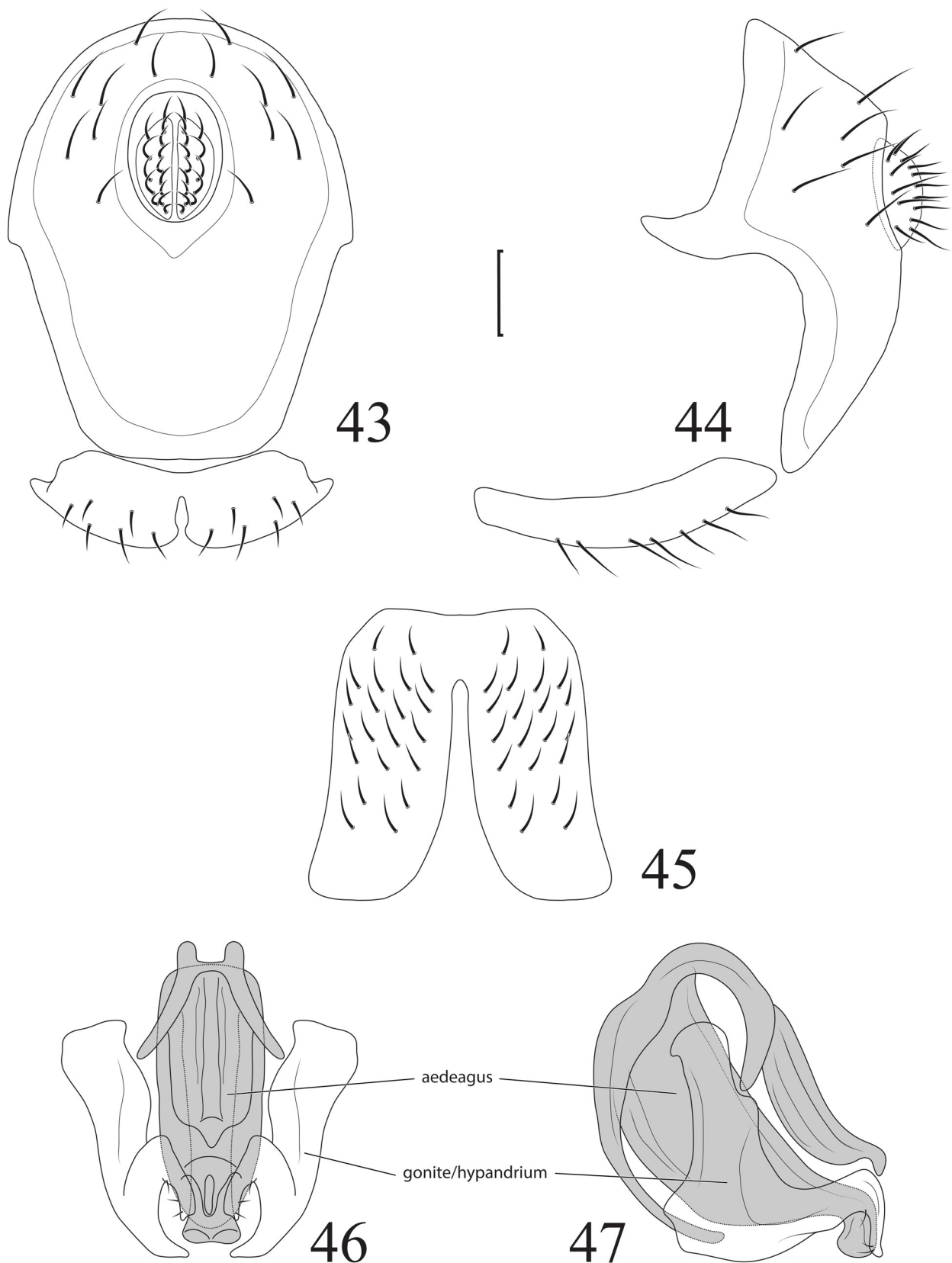
as the absence of ocelli, ocellar setae and the first abdominal tergite and a compact thorax. It is distinguished from *L. vounitis* by its larger size, yellowish face, and generally better developed setae. Structures of the male terminalia of this species are very different from *L. vounitis* and unique among congeners. Initially we thought the C-shaped and very narrow sclerite in lateral view was the phallapodeme. However, comparing these structures to those of *L. vounitis* and to other congeners with a rudimentary phallapodeme, we now suggest that the more accurate interpretation is that the phallapodeme is completely reduced. We suggest further that the C-shaped and very narrow sclerite in lateral view and the bowl-shaped sclerite together forms the aedeagus. This, however, remains a tentative interpretation. The gonite, as in the previous species, seems to be fused with the hypandrium.

According to the collector, the type series was found in leaf litter, which is another more typical niche for brachypterous species (Hackman 1964).

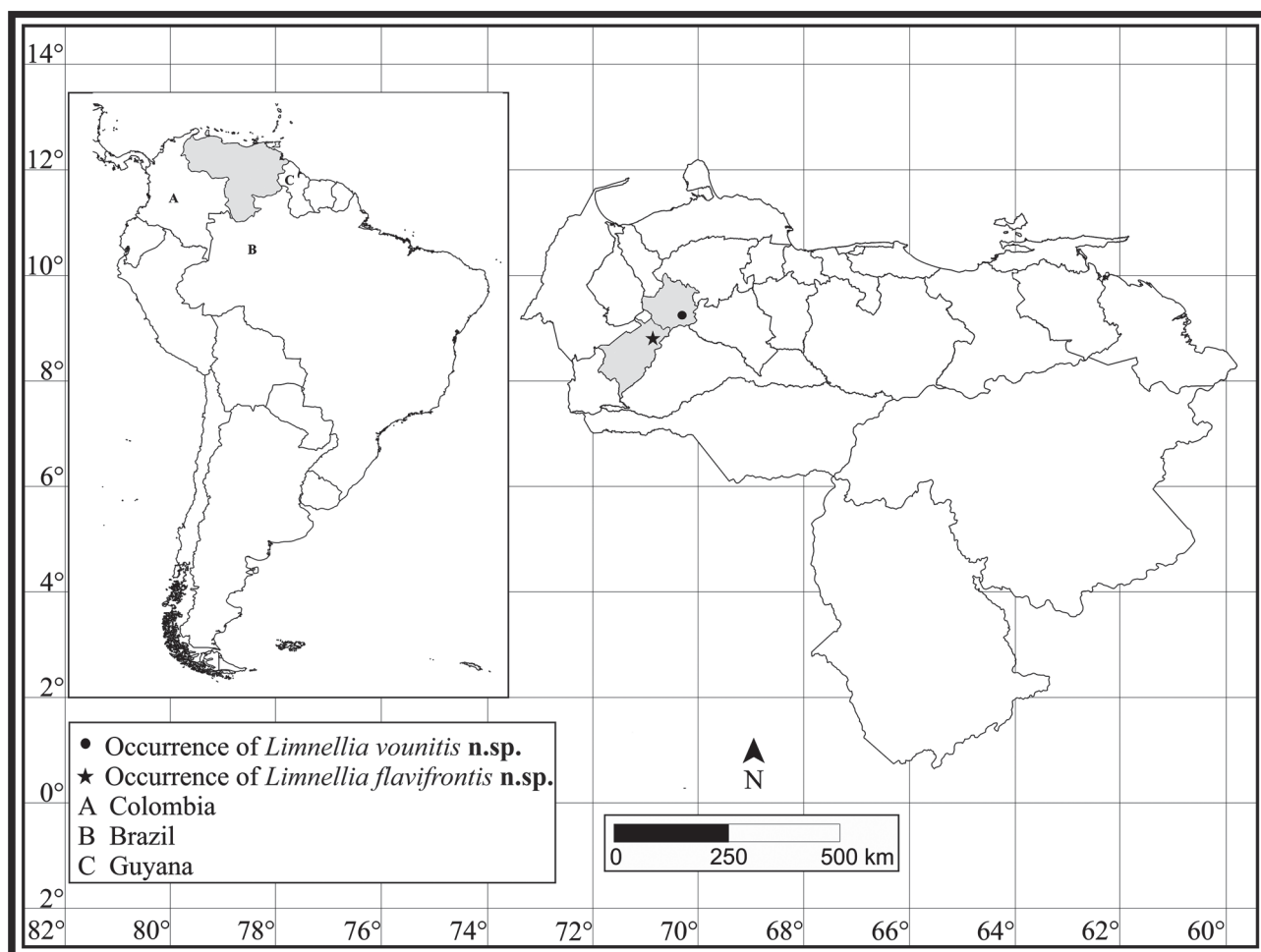


**FIGURES 38–42.** Male Terminalia of *Limnellia vounitis* n.sp. (38) Epandrium, cerci, fused surstylar plate, posterior view. (39) Same, lateral view. (40) Sternite 5, ventral view. (41) Aedeagus, gonite, sternite 5, ventral view. (42) Same, lateral view. Scale bar = 0.1 mm.





**FIGURES 43–47.** Male Terminalia of *Limnellia flavifrontis* n.sp. (43) Epandrium, cerci, surstylar plate, posterior view. (44) Same, lateral view. (45) Surstylar plate, ventral view. (46) Aedeagus, gonite, hypandrium, ventral view. (47) Same, lateral view. Scale bar = 0.1 mm.



**FIGURE 48.** Distribution map for *Limmellia vounitis* n.sp. and *Limmellia flavifrontis* n.sp.

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## References

- Andersson, H. (1971) The European species of *Limmellia* (Dipt., Ephydriidae). *Entomologica Scandinavica*, 2 (1), 53–59.  
<http://dx.doi.org/10.1163/187631271X00059>
- Clausen, P.J. & Cook, E.F. (1971) A revision of the Nearctic species of the tribe Parydrini (Diptera: Ephydriidae). *Memoirs of the American Entomological Society*, 27, 1–150.
- Collin, J.E. (1930) Some new species of the dipterous genus *Scatella* Dsv. and the differentiation of *Stictoscatella* gen. nov. (Ephydriidae). *The Entomologist's Monthly Magazine*, 66, 133–39.
- Cresson, E.T. Jr. (1930) Studies in the dipterous family Ephydriidae. Paper III. *Transactions of the American Entomological Society*, 56, 93–131.
- Cresson, E.T. Jr. (1935) Descriptions of genera and species of the dipterous family Ephydriidae. *Transactions of the American Entomological Society*, 61, 345–372.
- Dahl, R.G. (1959) Studies on Scandinavian Ephydriidae (Diptera Brachycera). *Opuscula Entomologica*, 15 (Supplementum), 1–224.

- Duda, O. (1942) Neue oder ungenügend bekannte Zweiflügler der paläarktischen Region aus meiner Sammlung. 2. Fortsetzung. *Deutsche Entomologische Zeitschrift*, 1942 (1–4), 1–39.  
<http://dx.doi.org/10.1002/mmnd.194219420102>
- Grimaldi, D.A. (1987) Phylogenetics and taxonomy of *Zygothrica*. *Bulletin of the American Museum of Natural History*, 186, 103–268.
- Hackman, W. (1964) On reduction and loss of wings in Diptera. *Notulae Entomologicae*, 44 (3), 73–93.
- Krivosheina, M.G. (2012) Review of the shore-fly genus *Limnelli* Malloch, 1925 (Diptera, Ephydriidae) of Russia. *Far Eastern Entomologist*, 246, 1–7.
- Malloch, J.R. (1925) Notes on Australian Diptera. No. vii. *Proceedings of the Linnean Society of New South Wales*, 50 (4), 311–340.
- Mathis, W.N. (1978) A revision of the Nearctic species of *Limnelli* Malloch (Diptera: Ephydriidae). *Proceedings of the Biological Society of Washington*, 91 (1), 250–293.
- Mathis, W.N. (1980) Studies of Ephydrinae (Diptera: Ephydriidae), III: Revision of some Neotropical genera and species. *Smithsonian Contributions to Zoology*, 303, 50 + iv pp.
- Mathis, W.N. (1986) Studies of Psilopinae (Diptera: Ephydriidae), I: A revision of the shore fly genus *Placopsidella* Kertész. *Smithsonian Contributions to Zoology*, 430, iv + 30 pp.
- Mathis, W.N. & Zatwarnicki, T. (1990a) A revision of the Western Palearctic species of *Athyroglossa* (Diptera: Ephydriidae). *Transactions of the American Entomological Society*, 116 (1), 103–133.
- Mathis, W.N. & Zatwarnicki, T. (1990b) Taxonomic notes on Ephydriidae (Diptera). *Proceedings of the Biological Society of Washington*, 103 (4), 891–906.
- Mathis, W.N. & Zatwarnicki, T. (1995) A world catalog of the shore flies (Diptera: Ephydriidae). *Memoirs on Entomology, International* 4, vi + 423 pp.
- Mathis, W.N., Marinoni, L. & Costa, D.N.R. (2014) A review of Scatellini Wirth and Stone (Diptera: Ephydriidae) from Brazil. *Zoologia. An International Journal of Zoology*, 28, 1–16.  
<http://dx.doi.org/10.1590/S1984-46702014000600005>
- McAlpine, J.F. (1981) Morphology and terminology-adults. In: McAlpine, J.F. (Ed.), *Manual of Nearctic Diptera. Vol. 1*. Research Branch Agriculture Canada, Monograph No. 27, pp. 9–63.
- Olafsson, E. (1991) Taxonomic revision of western Palearctic species of the genera *Scatella* R.-D. and *Lamproscatella* Hendel, and studies on their phylogenetic positions within the subfamily Ephydrinae (Diptera, Ephydriidae). *Entomologica Scandinavica*, 37 (Supplement), 1–100.
- Stuckenberg, B.R. (1999) Antennal evolution in the Brachycera (Diptera), with a reassessment of terminology relating to the flagellum. *Studia Dipterologica*, 6, 33–48.
- Wirth, W.W. & Stone, A. (1956) Chapter 14. Aquatic Diptera. In: Usinger, R.L. (Ed.), *Aquatic Insects of California*. University of California Press, Berkeley, pp. 372–482.
- Zhang, J. & Yang, D. (2009) Species of the genus *Limnelli* from China (Diptera: Ephydriidae). *Zootaxa*, 2308, 58–64.
- Zatwarnicki, T. (1996) A new reconstruction of the origin of eremoneuran hypopygium and its classification implications (Insecta: Diptera). *Genus*, 7 (1), 103–175.